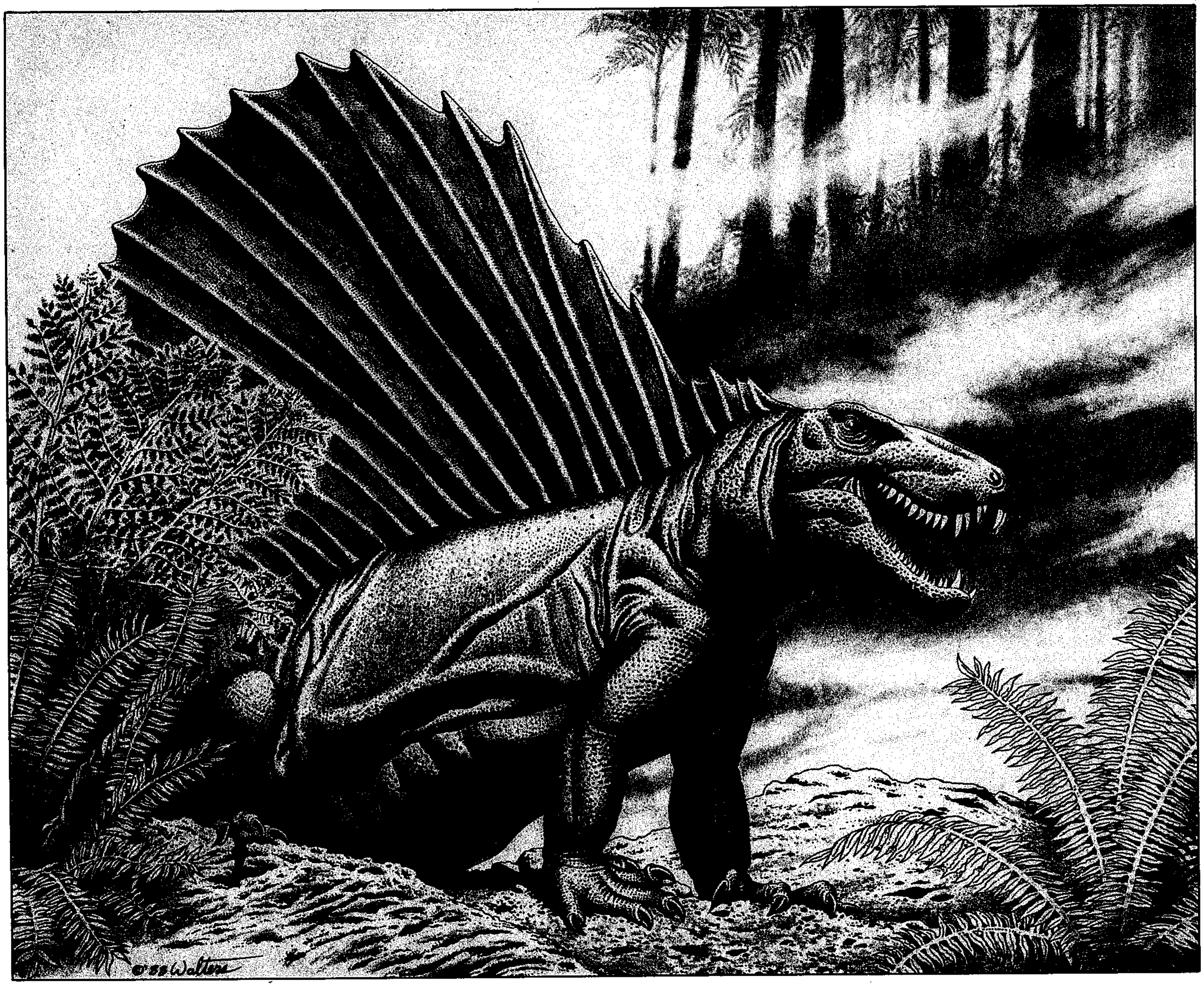
THE MOSASAUR



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The Mosasaur

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A Predator Attacks *Sphenodiscus*

Frank Bukowski, Paul Bond

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In 1981, during the excavation of a construction site in the Severn Formation near the junction of I-95 and Landover Road, Prince Georges County, Maryland, a number of fossils were uncovered. Marine and terrestrial reptilian fragments have previously been collected from this formation, including parts of turtles, pleisiosaurs, crocodilians, and mosasaurid lizards (Baird, 1986). At the I-95 site, members of the DVPS have colelcted various species of the Mollusca, Crustacea, Annelida, Anthozoa, Chondrichthyes, and Osteichthyes (Hartstein & Decina, 1986).

The Severn Formation (middle Maastrichtian) overlies the Matawan Formation (Campanian) and is overlain by a combined Brightseat-lower Aquia Formation (Paleocene). The Severn consists of dark to medium gray clayey, silty, poorly sorted, mostly fine- to medium-grained sparingly glauconitic quartz sand (Minard et al., 1977).

In November, 1982, the senior author found at the I-95 site an almost intact conch of the cephalopod *Sphenodiscus lobatus* (Tuomey). The shell was in a spoil pile derived from the highway construction project. The left side of the conch was covered with matrix while the right side was free of sediment, showing that the original shell was reasonably intact. As the matrix was being removed from the left side, a great amount of shell adhered to the separated matrix, exposing the sutures. The shell is approximately 23 cm in diameter. Matrix still adheres to the aperture (Plate 1, fig. 1).

While the fossil is of itself a fine museum piece, it is unusual due to a number of perforations on both sides of the phragmacone (Plate 1, figs. 1, 2). Since the publication of Kauffman & Kesling's (1960) landmark paper, workers have been intrigued with the detectable evidence of predation on fossil invertebrates, particularly on shelled cephalopods. This Severn Formation ammonoid raises the question as to the origin of the perforations.

The usual cause of perforations in fossil invertebrates is post-depositional compaction. Pebbles and even other fossils can rupture a hollow septal chamber as the sediments are compacted over time. The rare and unusual cause of performation sis that of an attack by a marine predator. As Elliott & Bounds (1987) have demonstrated, it is quite easy to mistake a perforation caused by post-depositional compaction for an animal attack.

To be assured that perforations on an ammonoid are cuased by a vertebrate predator, several conditions must be met. First, the marks of teeth in a jaw pattern should be present with countermarks on the other side reasonably aligned. "Reasonably" is subjective because the teeth ofmost marine predators do not perfectly occlude. Again, many marine vertebrates constantly lose and replace teeth. A perfect predator jaw-bite pattern on an ammonoid shell may be disrupted because the ammonoid presents an ovate shell that would be difficult for an attacker to bite and counter-bite perfectly. Second, post-depositional compaction perforations would be irregular in shape and size and random in position, while actual teeth marks should have a consistency of shape, size, and location. Third, in most cases hardly any shell material broken by the predator's teeth should be attached, but should have been crushed and driven inside the septal chamber. Thus, if the perforations are in a jaw-shaped pattern, with appropriate countermarks on the other side, if they are of uniform size and shape, and with hardly any shell material still adhering to the top of the hole, we can suppose that the marks are those of a predator.

The perforations on the *Sphenodiscus* from the I-95 site were analyzed, numbered, described, and judged as to whether they complied with our predation standards (Table 1). Those on the left were given the prefix "L," those on the right "R" (Figures 1, 2). Tracing paper was used on both sides to determine the position of the marks and the respective countermarks, if any. The two sides were then compositely aligned (Figure 3).

There are 26 perforation marks on the conch; 13 on the left and 13 on the right. All of the holes that are considered predation marks are in the same quadrant of the conch. Of the 26 marks, 20 were apparently made by a predator.

The marks numbered L1, L2, L3, L6, L8, L12, L13, R5, R7, R8, and R13 enclosed approximately the same area (ca. 75 mm). Also similar in shape but smaller in average area (17 mm) are L9, L10, L11, R6, R9, R10, and R11. This is not unusual because tooth loss and replacement results in different tooth lengths and consequent hole sizes at any one time. We consider mark L4 to be two tooth marks and have numbered them L4a and L4b. L5 is a bit larger than the other large marks and of a more irregular size. We consider this mark as one where one tooth entered and where in a later bite another tooth entered the same hole. L10 is a dent, not a perforation, and could be pterygoid tooth mark. Pterygoid teeth are suspended on the paired pterygoid bones on each side of the mouth roof parallel to, and not on, the jaw tooth line. They arenot as long as the maxillary teeth and would tend to make dents, not perforations. Their function was not one of biting but of grasping while food was positioned in the bock of the mouth (Colbert, 1965).

It would appear that the predator bit our ammonoid three times in the phragmocone and then bit at the soft parts in the aperture. Bites in the phragmocone would immediately flood the septal chambers. The animal would lose buoyancy and mobility. It would then be an easy target for the attacker. Bite

The Mosasaur, **4:69-74**
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Table 1.

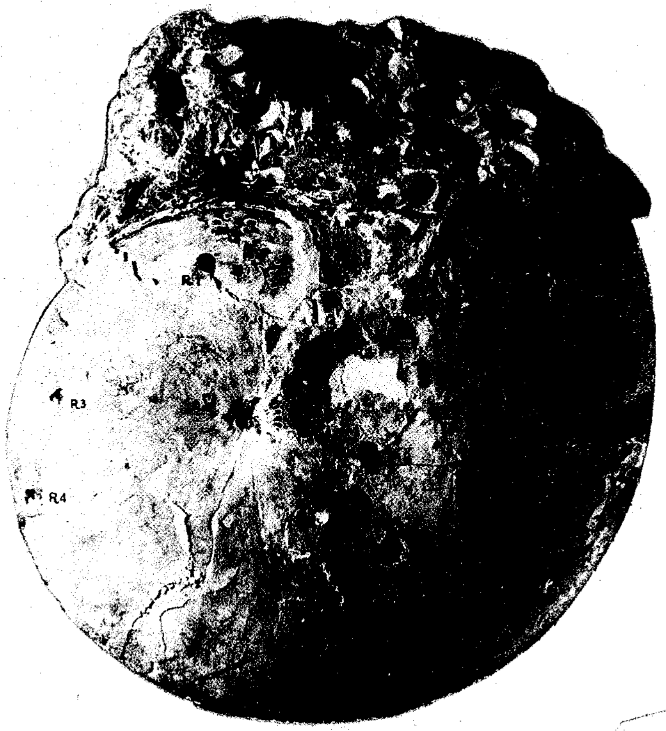
Analysis of perforated holes.

Hole Number	Hole Size (mm.)	Description	Tooth Mark ?	Comments
L1	10x8	Irregular oval	Yes	Counterpart of R13.
L2	8x6	Rounded oval	Yes	
L3	12x8	Irregular square	Yes	
L4	18x7	Ragged	Yes	Appears to be two
L5	12x9	Irregular rectangle	Yes	
L6	9x6	Hooded shape	Yes	Flat on one side
L7	4x3	Rounded	No	A suture saddle
L8	10x7	Oval	Yes	
L9	4x3	Oval	Yes	Raised - dent
L10	5x4	Oval	Yes	Raised - dent
L11	4x3	Oval	No	A suture saddle
L12	12x8	Oval	Yes	
L13	13x9	Oval	Yes	
R1	6x6	Hooded shape	No	Shell in hole - Post depositional
R2	4x3	Square	No	No counterpart
R3	5x5	Deep hole	No	No counterpart
R4	5x5	Deep hole	No	No counterpart
R5	13x9	Oval	Yes	
R6	4x4	Round	Yes	Dent - shell intact
R7	7x7	Round	Yes	
R8	11x7	Oval	Yes	
R9	5x4	Round	Yes	Dent - shell intact
R10	6x5	Round	Yes	Shell missing
R11	5x4	Hooded	Yes	Flat on septal side
R12	7x5	Oval	Yes	
R13	12x8	Oval	Yes	

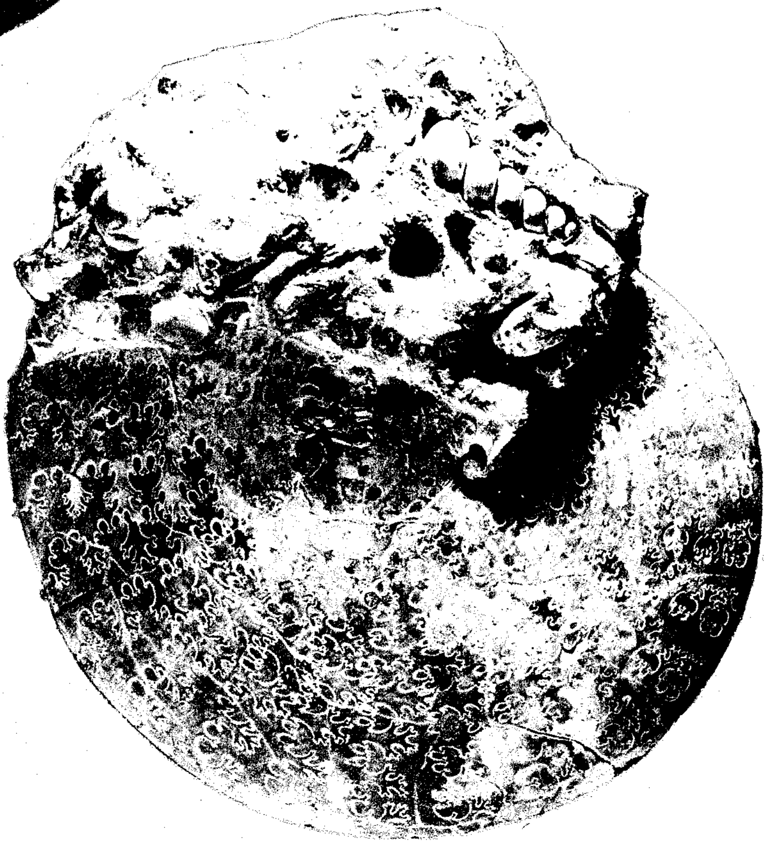
1 (Figure 4) was delivered from above on the ammonoid's blind side, piercing the shell at 11 sites. Bite 2, made by 7 teeth (Figure 5) was again from the top, slightly posterior to Bite 1. Bite 3, made by 4 teeth, was nearer the aperture (Figure 6). The ammonoid was probably tumbled by the lethal injuries of the first two bites, and the predator made Bite 3 in another sector of the conch. Figure 7 is a comosite of the intial three bites. Bite 4 was then made at the aperture, separating the body from the phragmocone. The perforated conch, with flooded chambers, rapidly sank to the bottom. The long period required for fossilization in the Severn Formation then began.

There is a degree of doubt as the specific animal that cuased the damage. We had only 20 holes confirmed as bite marks. The Kauffman and Kesling specimen had 53 distinguishable upper-teeth perforations and 37 lower-teeth perforations. It was possible then to establish that 16 separate bites were taken by that ammonoid, and that the predator was of the subfamily Platecarpinae.

The marine predators of the time, other than mosasaurs, were turtles, elasmosaurs, crocodiles, sharks, bony fish, and pliosaurs (Halstead, 1968). Turtles, without teeth, could only crunch the entire shell of an ammonoid. Elasmosaurs are also an unlikely candidate because their teeth are smaller than those indicated here. Ichthyosaurs were probably extinct by the Maastrichtian (Baird, 1984). Crocodiles have a jaw shape that would not fit this pattern (Williston, 1925). Sharks and bony fish would not have made these rounded and oval holes. Pliosaurs are a candidate because some species in the latter part of the Late Cretaceous had massive, blunt teeth not closely packed in the jaw (Colbert, 1965). Other plesiosaurs, cf. *Cimoliasaurus*, whose teeth are found in the Severn Formation, had slender teeth that at full penetration could produce the bite marks seen on the



Sphenodiscus lobatus,
left side (x 0.4).



Sphenodiscus lobatus,
right side (x 0.39).

Figures 1-7. I-95 specimen of *Sphenodiscus lobatus* (Tuomey) showing patterns of bite marks discussed in the text (all X 0.36).

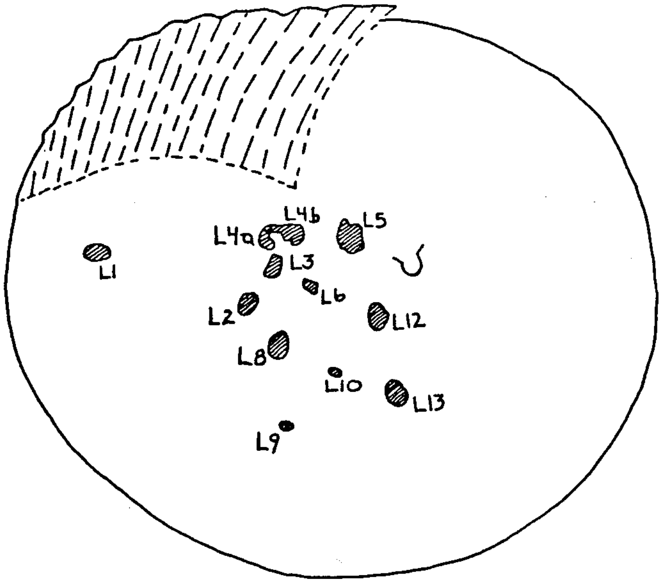


Figure 1: Left side (x 0.36)
Perforation marks

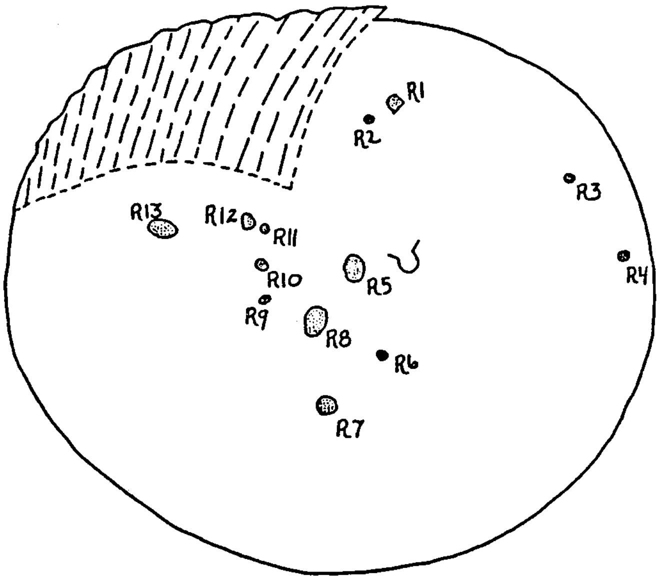


Figure 2: Right side (x 0.36)
Perforation marks

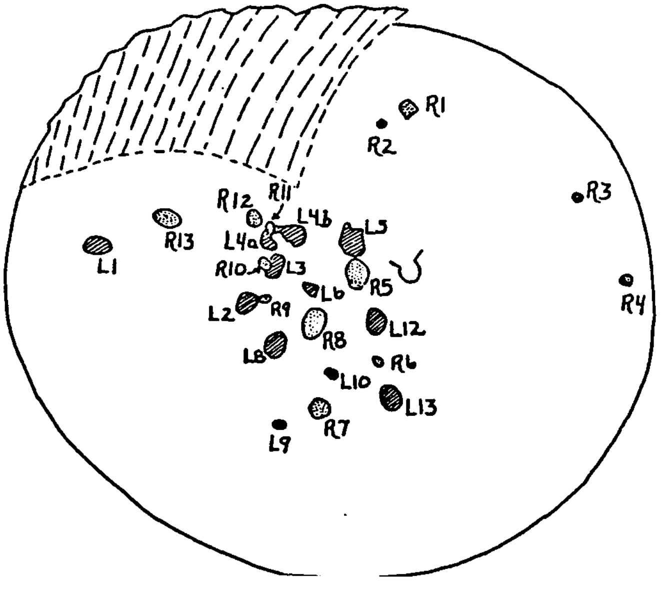


Figure 3: Composite (x 0.36)
Perforation marks

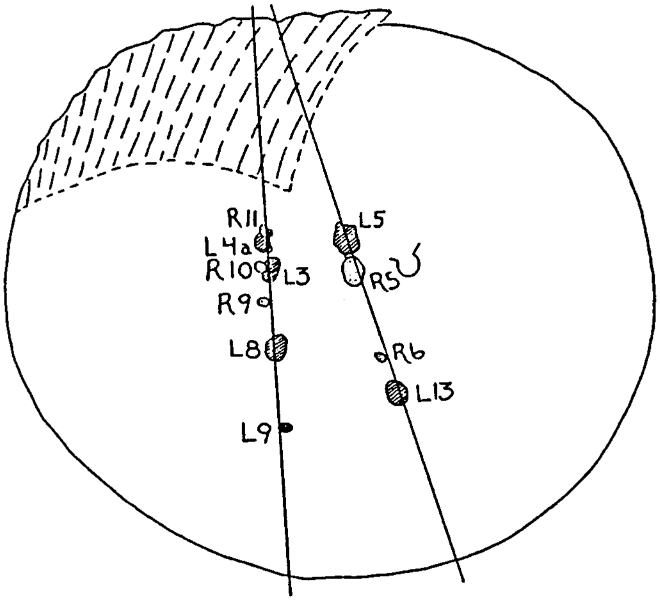


Figure 4: Bite 1
on left: L9, L8, R9, L3
L10, L4a, R11
on right: L13, R6, R5, L5

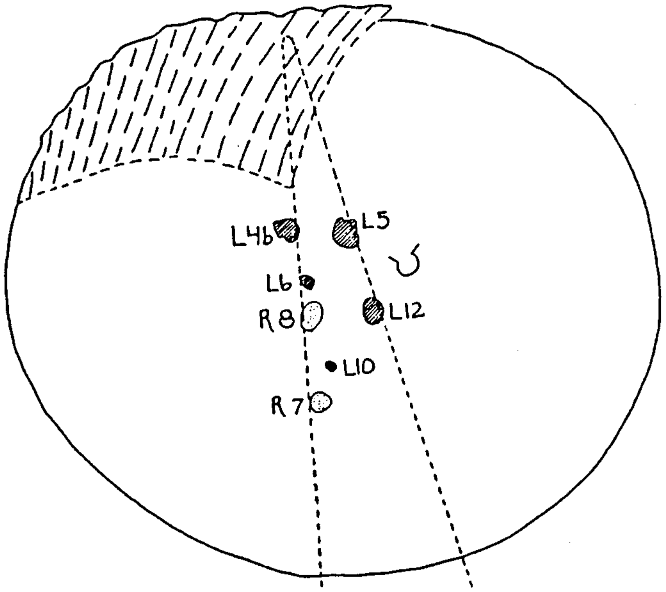


Figure 5: Bite 2
on left: R7, R8, L6, L4b
on right: L12, L5
pterygoid tooth: L10)

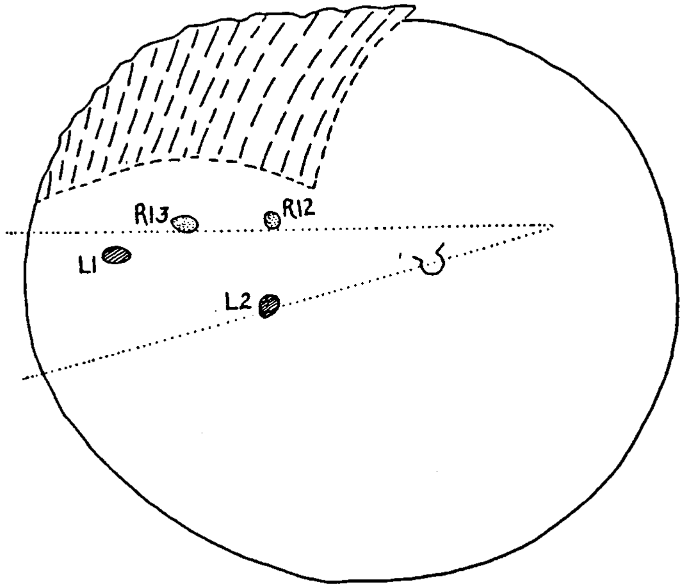


Figure 6: Bite 3
on left: L1, R13, R12
on right: L2

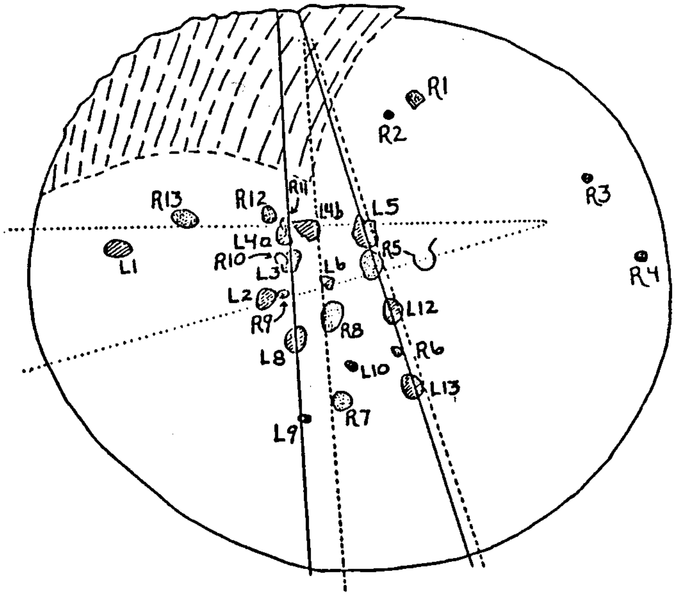


Figure 7: Composite
All three bites.

Sphenodiscus (D. Baird, personal communication). However, we have no further evidence because the skull of this plesiosaur is unknown, so we cannot say whether or not its jaw angle conforms to the bite marks seen on the ammonoid.

If we are correct that L10 is the mark of pterygoid tooth, then the predator was a mosasaur because it is the only Cretaceous marine reptile with pterygoid teeth (Colbert, 1965). In addition, the angles of mosasaur jaws vary from 17° to 22° (Williston, 1898). the bite marks on this *Sphenodiscus* are at an angle of 18°. This would at first seem to be unequivocal evidence that the predator was a mosasaur. However, as pterygoid teeth occur in a row, there should be more than one impression in a given bite. There is only one supposed pterygoid tooth mark (L10) and no others aligned with it. Thus, the conclusion that the predator was a mosasaur is weak. What we can say with certainty is that the Cretaceous *Sphenodiscus* was attacked and killed by a marine reptile--either a mosasaur or plesiosaur--in the Maastrictian 70 million years ago.

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